

TECHNICAL SPECIFICATIONS

Greenhorn Creek Fish Barrier

These technical specifications address all anticipated construction and excavation activities to be completed during the Greenhorn Creek Fish Barrier installation.

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SECTION 01000
SUMMARY OF WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Related Documents
- B. Summary Scope of Work

1.02 RELATED DOCUMENTS

- A. Sheets and Figures included in Appendix A
 - 1. Sheet 1 – Cover
 - 2. Sheet 2 – Site Plan
 - 3. Sheet 3 – Foundation Plan
 - 4. Sheet 4 – Barrier Plan
 - 5. Sheet 5 – Barrier Section and Details
 - 6. Sheet 6 – Concrete Section and Details
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 - 8. Sheet 8 - Backfill Plan
 - 9. Sheet 9 – Backfill Plan Typical Sections
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1.03 SUMMARY SCOPE OF WORK

The scope of work addressed by these plans and specifications consists of installation of a concrete fish barrier wall, along with downstream and upstream erosion protection on the Greenhorn Creek for Montana Fish Wildlife and Parks (FWP).

The Contractor or Contractors shall perform the following work per these specifications:

- A. Install one fish barrier structure with associated erosion protection.

END OF SECTION 01000

SECTION 01010
GENERAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. PROGRESS SCHEDULES
- B. TEMPORARY FACILITIES AND SITE CONTROL
- C. CONSTRUCTION SURVEYING
- D. SUBMITTALS
- E. TRAFFIC CONTROL AND SITE SAFETY
- F. EROSION AND SEDIMENT CONTROL
- G. CONSTRUCTION SEQUENCING AND OTHER CONTRACTORS
- H. EXISTING STRUCTURES
- I. RECORD KEEPING REQUIREMENTS

1.01 PROGRESS SCHEDULES

Contractor shall prepare an initial project schedule and shall update and maintain the schedule appropriately. Copies of all initial schedules and updates shall be provided to the ENGINEER upon request.

1.02 TEMPORARY FACILITIES AND SITE CONTROL

Contractor shall notify and coordinate with all appropriate utility companies and ENGINEER before conducting work proximate to overhead or buried utilities.

1.03 CONSTRUCTION SURVEYING

Contractor shall provide all construction surveying needed to complete the work.

1.04 SUBMITTALS

Contractor shall provide product information and submittals for the following items:

1. Re-bar;
2. Concrete mix;
3. BMP Plan;
4. Stream Diversion Plan; and
5. Other items as required by Engineer.

1.05 TRAFFIC CONTROL AND SITE SAFETY

Traffic control and site safety shall be the sole responsibility of Contractor. Adequate signs, barricades, cones, drums, barriers, lighting, flagmen, security guards, and other methods or devices shall be utilized.

1.06 EROSION AND SEDIMENT CONTROL

- A. Temporary diversions for storm runoff or Greenhorn Creek flows shall be conducted as specified in Section 02270 and as needed to direct flows around the work area. These diversions shall be designed, implemented and maintained by the Contractor in accordance with Best Management Practices (BMPs) to control erosion and sediment release into Greenhorn Creek. BMPs may include, but are not limited to, temporary berms, cofferdams, sediment basins, ditches, silt fencing, straw bales, straw mulch, and erosion control matting.
- B. The Contractor shall plan and execute work to control and minimize surface runoff from cuts, fills, and other disturbed areas. The Contractor shall prevent sediment and/or sediment-laden water from entering Greenhorn Creek to the extent practicable.
- C. Dewatering: All dewatering flows collected from open sumps, trenches or excavations shall be routed through sediment retention structure prior to discharge to Greenhorn Creek. The Contractor shall comply with the dewatering requirements of Section 02140. All storm runoff flows from work areas also shall be routed through sediment retention structure prior to discharge.
- D. Greenhorn Creek Reconstruction

Best Management Practices (BMPs) measures shall be installed along Greenhorn Creek prior to any earthwork which could release sediment to Greenhorn Creek. BMPs shall remain in place until vegetation is established, as approved by ENGINEER. The methods implemented by the Contractor will be monitored by ENGINEER to assure compliance with BMPs.

1.07 CONSTRUCTION SEQUENCING AND OTHER CONTRACTORS

Contractor shall coordinate his construction activities with those of any and all other contractors that may be working on the site or adjacent sites. Contractor's work shall be conducted in a manner that will not impede the progress of other concurrent construction activities.

1.08 EXISTING STRUCTURES

- A. The Contractor shall notify and coordinate with all appropriate utility companies and with ENGINEER to field-locate overhead or buried utilities, wells, and other existing structures prior to construction. Location, depth, size, and material of existing buried utilities within excavation limits shall be verified prior to beginning construction.
- B. The Contractor shall be responsible for protecting existing structures within and external to the construction area not specified for demolition. Any damage to existing structures, whether above or below ground level, shall be repaired to the owner's satisfaction by the Contractor at no additional cost to FWP. The existing wood structure in the stream channel shall be removed.
- C. Adjacent properties may have cattle or bison on them while the project is underway. Gates will need to be kept closed and fencing will need to remain intact or temporary fencing maintained to control livestock. **In no case is an opening to be left in the fencing overnight.**

1.09 SITE ACCESS

- A. Site access is via the Snowcrest Ranch
- B. Snowcrest Ranch Contact: Dave Dixon (406)-842-5379 (office), 406-842-5553 (shop)

END OF SECTION 01010

SECTION 02110
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of surface debris.
- B. Clearing and grubbing of all vegetation including trees, shrubs, and grass.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 PROTECTION

- A. Locate, identify, and protect existing utilities from damage.
- B. Protect benchmarks and existing structures from damage or displacement.

3.02 CLEARING

- A. Clear all surface debris and vegetation, including the root zone, from all areas impacted by the Work and as required for access to site and execution of Work as shown on the Drawings, and as directed by ENGINEER
- B. Remove identified trees, shrubs, stumps, roots, brush, rubbish, and other objectionable material within work areas and from the surfaces of all borrow areas and stockpile sites.
- C. Existing wood diversion structure to be removed.

3.03 REMOVAL

- A. Removed trees with diameters greater than 2-inches shall be cut into 6-foot lengths and stockpiled on site as directed by ENGINEER. Smaller woody material shall be chipped and disposed of as directed in paragraph B.
- B. Remove debris, rock, and extracted vegetation and dispose of materials by spreading debris in adjacent forest as directed by ENGINEER.

END OF SECTION 02110

SECTION 02140
CONSTRUCTION DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies dewatering requirements and procedures necessary during installation and use of dewatering pumps and appurtenances, groundwater collection trenches/sumps, and dewatering wells and/or wellpoints.

1.02 RELATED SECTIONS

Section 02200 - Unclassified Excavation
Section 02220 - Trench Excavation and Backfill

1.03 SUBMITTALS

- A. The Contractor shall submit a Construction Dewatering Plan to ENGINEER prior to executing the work. The Construction Dewatering Plan shall be a written procedure for implementing the construction dewatering requirements specified herein. The plan shall describe the layout, materials, and equipment, and the operation and maintenance procedures proposed.

1.04 DESCRIPTION OF SITE CONDITIONS

- A. The site condition description provided herein is based on surface observations.
1. General: Within the project area, Greenhorn Creek flows in a south westerly direction and is incised into the valley fill approximately 5.5 feet. The left side (looking downstream) and right side of the channel are bounded by a terrace. Immediately upstream of the barrier site is the confluence of the South Fork and North Fork of Greenhorn Creek. The channel bed in the area of the proposed structure appears to be gravel. The streambed immediately upstream of the barrier is irregular and comprised of gravels. An wooden headgate, diversion structure and diversion ditch exists at the barrier site. The ditch is not currently active. The wood diversion structure is to be removed as part of the construction activities.

2. Groundwater: No groundwater discharge points were observed during the field work. Therefore it is anticipated that local groundwater levels are at or below the stream channel water surface elevations.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. The Contractor shall provide, and maintain on site, all equipment, piping, fittings, and appurtenances necessary to collect, pump, and convey discharge water to adequately dewater all open excavations, including spare fittings, pumps and other materials necessary to maintain a continuously operating dewatering system.
- B. The Contractor shall provide and maintain primary and backup power supplies and power distribution systems as necessary to operate the dewatering system without significant interruption. All grounding shall be provided per the NEC. The power plants and their appurtenances shall be protected from weather and other potentially detrimental conditions at the site (e.g., dust, impacts, etc.)
- C. The Contractor shall provide all necessary equipment and materials to collect and pump dewatering flows.

PART 3 EXECUTION

3.01 DEWATERING

- A. The Contractor shall fully implement all measures and precautions necessary to ensure the safety of workers, and the protection of the Work (including maintenance of integrity against rupture and/or heave of the bottom of the excavation) during excavation and dewatering, including, but not limited to, full implementation of the requirements of this Section 02140.
- B. The Contractor shall provide backup and spare equipment (as specified in Part 2.01), immediately available for installation and/or operation to minimize any interruption in the required pumping. In the event of pump failure for reasons beyond the Contractor's ability to control, all excavation shall cease, and the Contractor shall implement repairs and resume pumping as soon as possible.

- C. Maintain excavation dewatering sufficiently to allow for visual inspection, quality assurance, and as-built surveying, to be conducted by ENGINEER at their discretion.

END OF SECTION 02140

SECTION 02200
UNCLASSIFIED EXCAVATION

PART 1 GENERAL

SECTION INCLUDES

- A. Work under this Section includes unclassified excavation associated with the installation of the Greenhorn Creek Fish Barrier.

1.02 RELATED SECTIONS

Section 02110 - Clearing and Grubbing
Section 02140 - Construction Dewatering
Section 02210 - Fill Materials and Placement

1.03 REGULATORY REQUIREMENTS

- A. Sheeting, Shoring, and Bracing: Except where trench banks are cut back on a stable slope, provide and maintain all sheeting, shoring, and bracing necessary to protect workers, and to protect adjoining grades and structures from caving, sliding, erosion or other damage in accordance with Occupational Safety and Health Standards (29 CFR Part 1926 - Construction Standards for Excavations), the Site Specific Health and Safety Plan, and other applicable codes and governing authorities.

1.04 FIELD MEASUREMENTS

- A. Verify that survey coordinates and elevations indicated on the Drawings are accurate as indicated. Notify ENGINEER of any discrepancies prior to construction.

PART 2 PRODUCTS (Not used)

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Accurately locate, identify, and protect from damage all utilities, benchmarks, monitoring wells and other structures not designated for demolition. The Contractor is responsible for verifying that all utilities

through the work area have been accurately located prior to excavation, and that no conflicts exist.

- C. If temporary diversions for storm runoff or base flows are deemed necessary by the Contractor, they shall be designed, implemented and maintained by the Contractor as specified in Section 01010, Part 1.06.

3.02 EXCAVATION

- A. Excavation shall conform to the boundaries, elevations, and excavation slopes shown on the Drawings. Limits of excavation shall be the minimum required to complete the Work.
- B. Remove loose material, lumped subsoil, boulders, and loose rock from excavations leaving excavation surface exposed and clean.
- C. Graded areas shall be sloped to promote surface drainage and discourage ponding.
- D. Stockpile excavated materials suitable for backfill along the excavation at a safe distance in accordance with Occupational Safety and Health Regulations, in areas not susceptible to erosion and other applicable codes and governing authorities. Excavated materials not suitable for backfilling shall be wasted on site as directed by ENGINEER. Wasted material shall be revegetated in accordance with Section 02910.

3.03 PROTECTION

- A. Protect excavations as required to prevent cave-in or loose soil from falling into excavation.

3.04 TOLERANCES

- A. Excavate to within ± 0.2 feet of elevation and location as shown on the Drawings.
- B. Maintain excavation dewatering sufficiently to allow for visual inspection and as-built surveying, to be conducted by ENGINEER at their discretion.
- C. Any areas of over-excavation shall be filled with Type A Fill or Type B Fill, as directed by ENGINEER and at no additional cost to FWP.

3.05 FIELD QUALITY CONTROL

- A. Provide for access, visual inspection, and construction surveying of excavation surfaces as required by ENGINEER.

END OF SECTION 02200
SECTION 02210
FILL MATERIALS AND PLACEMENT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

This section specifies fill materials, borrow areas/sources of fill materials, and fill placement requirements for the following:

1. General Site Backfill;

1.02 RELATED SECTIONS

Section 03300 – Cast In Place Concrete
Section 02270 – Stream Channels and Diversions

1.03 SUBMITTALS

Submit data sheets and test results from compliance testing of materials provided by Contractor to ENGINEER for review and approval.

1.04 REFERENCES

A. Sampling and Preparation

1. ASTM D75 - Standard Practice for Sampling Aggregates.
2. ASTM D420 - Recommended Practice for Investigating and Sampling Soil and Rock.

B. Classification

1. ASTM D421 - Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
2. ASTM D422 - Standard Method for Particle-Size Analysis of Soils.
3. ASTM D2487 - Classification of Soils for Engineering Purposes.

4. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. Density and Moisture Content: Field

1. ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
2. ASTM D2922 - Test Methods for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth).
3. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

D. Density and Moisture Content: Laboratory

1. ASTM D698 or AASHTO T99 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
2. ASTM D1557 or AASHTO T180 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
3. ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
4. ASTM D4253 - Maximum Index Density of Soils Using a Vibratory Table.
5. ASTM D4254 - Minimum Index Density of Soils and Calculation of Relative Density.
6. ASTM D4643 - Determination of Water (Moisture) Content of Soil, Microwave Oven Method.
7. ASTM D4718 - Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

- A. Type A Fill: General fill free of debris, deleterious or objectionable materials, and rocks larger than 6-inches. Type A Fill shall be a compactable, well-graded, granular material approved by Engineer. Type A fill may be used for temporary roads, berms, cofferdams or dikes, or other temporary structures built for construction purposes and as granular backfill material to be used to backfill the retaining walls.
- B. Type B Fill: Granular bedding material conforming to the following gradation criteria unless otherwise approved by the Engineer, to be used under the apron and other bedding as shown on the Drawings.

<u>Particle Size</u>	<u>% Finer Than</u>
1-inch	100
3/4-inch	85-100
3/8-inch	30-60
#4 sieve	0-10

- C. Type C Fill: Clean, naturally occurring backfill for excavated areas and for construction of berms or other structural fill features. Type C Fill shall conform to the following gradation criteria and have a Plasticity Index less than 10, or otherwise approved by the Engineer:

<u>Particle Size</u>	<u>% Finer Than</u>
6-inch	90-100
#200 sieve	0.5-20

- D. Growth Media: Growth Media is defined as topsoil (A horizon material) and subsoil (B horizon material). Unless otherwise directed by the Engineer, growth media shall be stripped from all proposed disturbed areas within the project limits to a depth of 1 foot measured from the top of ground surface following clearing and grubbing. Stripped cover soil shall be stockpiled on site in an area where it will not interfere with construction activities and is not susceptible to erosion. The cover soil stockpile shall be of such uniformity and dimensions it can be conveniently measured by cross-section.

2.02 SOURCE QUALITY CONTROL

- A. Contractor shall submit 1 particle size analysis per 1000 cy for imported soil products. Tests and analyses of soil materials will be performed in accordance with applicable ASTM test methods, as listed under Part 1.04.

- B. If tests indicate materials do not meet specified requirements, change material and retest at no cost to FWP

PART 3 EXECUTION

3.01 SOURCE OF MATERIALS

- A. Contractor shall be responsible for locating suitable sources of Type A, B and C Fill.
- B. Growth Media shall be salvaged on sight as specified in Part 2.01 D.

3.02 PREPARATION FOR PLACEMENT

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain from damage, including all monitoring wells. Notify utility companies for utilities which may be affected by the work, or which cross the work area.
- D. Protect bench marks and existing structures from excavating equipment and vehicular traffic.
- E. Compact subgrade or existing underlying fill to a minimum depth of 12 inches to meet density requirements for subsequent fill materials as specified in Part 3.04.
- F. Cut out soft areas of subgrade or existing underlying fill that cannot be compacted as specified in paragraph E, above. Backfill with material type specified for subsequent fill, and compact to minimum density requirements for subsequent fill material as specified in Part 3.04. Over excavation required by Engineer will be paid for under a Change Order.
- G. Dewater area as needed prior to fill placement. Fill may not be placed if groundwater is present.

3.03 PLACEMENT

- A. General Backfilling of Excavated Areas and Other General Fill
 - 1. Place fill in lifts not to exceed 3 feet in loose thickness. Thinner lifts must be used if required to achieve compaction criteria presented in

Part 3.04 paragraph A, below.

2. Finish grade to within ± 0.2 foot of line and ± 0.1 % of grade shown on the Drawings.
3. Maintain positive surface drainage to minimize ponding of water on fill.
4. Material shall not be frozen when placed. Material shall not be placed on ice. Material shall not be placed on frozen material unless directed by Engineer. Frozen material shall be scarified, disked, or otherwise made suitable to receive subsequent fill and provide an acceptable bond between lifts, as approved by Engineer.

B. Backfilling of Structure, Retaining Wall and Apron Subgrade

1. Place fill in lifts not to exceed 12 inches in loose thickness. Thinner lifts must be used if required to achieve compaction criteria presented in Part 3.04 paragraph B, below.
2. Finish grade to within ± 0.2 feet of line
3. Material shall not be frozen when placed. Material shall not be placed on ice. Material shall not be placed on frozen material unless directed by Engineer. Frozen material shall be scarified, disked, or otherwise made suitable to receive subsequent fill and provide an acceptable bond between lifts, as approved by Engineer.

C. Berm Fill and other Structural Fill

1. All surfaces upon or against which structural fill will be placed, including previously placed and compacted layers, shall be free of all objectionable materials in accordance with Section 02110 - Site Clearing, shall be relatively flat in preparation for subsequent fill placement, shall be moist but free of standing or ponded water, unless otherwise approved by the Engineer, and shall be scarified as necessary so as to provide a suitable bond between the existing and subsequently placed material.
2. Place fill of type designated on Drawings in lifts not to exceed 12 inches in loose thickness.
3. Finish grade to within ± 0.2 foot of line shown on the Drawings for embankment slopes, and within $+ 0.3$ foot on embankment crests.

4. Maintain positive surface drainage to prevent ponding of water on fill.
5. Material shall not be frozen when placed. Material shall not be placed over ice. Material shall not be placed on frozen material unless directed by Engineer. Frozen material shall be thawed, scarified, disked or otherwise made suitable to receive subsequent fill and provide an acceptable bond between lifts, as approved by Engineer.

3.04 COMPACTION

- A. General Backfilling of Excavated Areas and Other Non-Structural Fill Density: Materials shall be compacted sufficiently to support traffic by construction equipment, construction surveying, and inspection vehicles.
- B. Type A and C material, berm and retaining wall backfill shall be compacted to a firm, unyielding surface as approved by Engineer.
- C. Type B Apron Slab Subgrade: Place Type B material by dumping from a height no less than 1 foot and no greater than 5 feet. Spread material evenly with rake or shovel to ensure uniform distribution of material throughout area of backfill. Mechanically tamp a minimum of three passes with the tamper.

3.05 SITE GRADING

Grade all areas including excavated, filled, and transition areas to obtain the finished surface shown on Drawings, to the tolerances specified in Part 3.03 above. Finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. Finished surfaces shall have positive drainage to minimize ponding of water.

3.06 FIELD QUALITY CONTROL

- A. Observation of compaction control and gradation will be conducted by Engineer. Compacted fill, not meeting the requirements of these specifications shall be corrected at no additional expense to FWP.
- B. Contractor shall perform all initial control and grade staking during construction. Contours and elevations not meeting the requirements of these specifications shall be corrected at the Contractor's expense.

END OF SECTION 2210

SECTION 02270
STREAM CHANNELS AND DIVERSIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

This Section includes all grading, excavation, and backfill required for all storm drainage and channel reconstruction needed to complete the Work. This shall include construction of stream channels and diversions; furnishing, hauling and placing riprap material; furnishing, placing and constructing riprap aprons for surface water inlet/outlet structures; and furnishing materials for diversion dams in accordance with the Drawings and these Specifications.

1.02 RELATED SECTIONS

Section 02210 - Fill Materials and Placement Requirements
Section 02220 - Pipe Trenching, Backfilling, and Compacting
Section 02620 - Corrugated Metal Pipes and Outlet Works
Section 02710 - Geosynthetic Materials

1.03 SUBMITTALS

Submit the following to ENGINEER:

- A. Materials Source/Product Data: Submit material source and manufacturer specifications on items proposed for use and as specified herein.
- B. Laboratory Test Results: Submit data sheets and test results from compliance testing of materials supplied by Contractor to ENGINEER for review and approval.

1.04 REFERENCES

Codes and Standards: Comply with provisions of following, except as otherwise indicated:

- A. AASHTO - M147 - Materials for Aggregate and Soil-Aggregate.
- B. AASHTO T11 and T27 or ASTM C136 - Methods for Sieve Analysis of Fine and Coarse Aggregates
- C. ASTM D75 - Standard Practice for Sampling Aggregates.
- D. ASTM D422 - Standard Method for Particle-Size Analysis of Soils.

- E. For Backfill and Compaction - Reference standards as listed in Section 02210, Part 1.04.

PART 2 PRODUCTS

2.01 DIKE/ROAD MATERIALS

- A. Type A Fill: General, clean fill for backfilling of excavated areas, and for construction of dikes, roads or other features which may encroach on the active stream channel or areas of standing water in channel overbank areas, as specified in Section 02210.

2.02 RIPRAP

Riprap shall be installed at the locations and to the dimensions indicated on the Drawings. The stone shall be hard, durable, sub-rounded to angular in shape, resistant to weathering to water and to ice action; free of excess amounts of thin flat, and elongated pieces, free from overburden, spoil, shale, structural defects, and organic material. The smaller stone shall be uniformly distributed throughout the work. The rock shall be manipulated by hand or machine methods sufficiently to secure a uniform surface and mass stability.

- A. Type 1 Riprap: Shall be classed as random riprap conforming to the following gradation:

Weight of Stone (lbs)	Equivalent Spherical Diameter (ft)	% of Total Weight Passing
700	2.0	100
500	1.79	70-90
200	1.32	40-60
20	0.61	0-10

2.03 SOURCE QUALITY CONTROL

- A. Tests and analysis of soil material will be performed in accordance with applicable ASTM test methods.
- B. If tests indicate materials do not meet specified requirements, change material and retest at no cost to FWP.
- C. Compliance testing will be performed by ENGINEER at its discretion.

PART 3 EXECUTION

3.01 SOURCE OF MATERIALS

- A. Contractor is responsible for locating a source of Type 1 Riprap.

3.02 TEMPORARY STREAM DIVERSIONS OF GREENHORN CREEK

- A. Prior to beginning any Work which requires stream diversion, Contractor must submit a Stream Diversion Plan for Engineer approval **2-weeks prior to** implementing any diversions of Greenhorn Creek. Contractor diversion plans are subject to specific review and approval by Engineer.
- B. No excavation may be performed within the existing channel of Greenhorn Creek prior to construction of a suitable diversion of the stream around all work areas.
- C. All stream diversions shall have the capacity to convey 20 cfs with a minimum of 1-foot freeboard required for open channels and minimum 1-foot of freeboard required above pipe inlet water surface elevation at the design flow.
- D. Appropriate erosion protection must be addressed in the Contractor's Stream Diversion Plan.

3.03 RECONSTRUCTED CHANNEL FOR THE GREENHORN CREEK

- A. Erosion protection must be provided in the reconstructed stream channel, and must meet with ENGINEER approval, prior to introducing Greenhorn Creek flows.

3.04 OTHER STORM FLOW DIVERSIONS

- A. Other storm flow diversions may be constructed as needed to trap sediment and direct flows using Best Management Practices (BMPs). BMPs may include, but are not limited to, construction of temporary berms, sediment basins, ditches and channels. Other temporary storm runoff control BMPs may be required to control sediment release into Greenhorn Creek. Temporary storm runoff control BMPs may include, but are not limited to, silt fencing, straw bales, straw mulch, hydroseeding, and erosion control matting. Such measures must be implemented prior to beginning work in areas, which would be impacted by storm flows.

3.05 EXCAVATION

All excavation for diversions or stream channels shall meet with the specifications of Section 02200.

3.06 DIKE CONSTRUCTION

Construction of all dikes for diversions or stream channels shall meet with the specifications of Section 02210 related to embankments and structural fills.

3.07 RIPRAP

- A. Riprap shall be placed in accordance with the details shown in the Drawings.

- B. Placement of riprap shall start at the toe of the slope and proceed up the slope. The riprap shall be placed such that damage to the Geotextile layer does not occur. Riprap shall not be dropped onto the Geotextile. Geotextile displaced or otherwise damaged during placement shall be replaced as directed by ENGINEER at the Contractor's expense.

- C. Placement of riprap for aprons of inlet/outlet structures shall follow the same installation procedures as previously mentioned. Geotextile shall be placed and anchored in accordance with specifications listed in Section 02710, the manufacturer's recommendations, and the details shown on the Drawings.

- D. The Contractor shall endeavor to place the riprap in such a manner as to minimize the slope roughness and present as smooth a surface to the stream flow as practical.

END OF SECTION 02270

SECTION 02710
GEOSYNTHETIC MATERIALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This section includes product specifications for geotextile materials, storage, and handling guidelines, and installation procedures for geotextiles and geomembranes used for the following:

- A. Filter fabric and temporary erosion protection.
- B. Silt fencing for sediment control.

1.02 RELATED SECTIONS

Section 02210 - Fill Materials and Fill Placement Requirements
Section 02270 – Stream Channels and Diversions

1.03 SUBMITTALS

Submit the following to ENGINEER:

- A. Product Data: Submit catalog data or brochures or manufactured items specified herein proposed for use.
- B. Certificates of Compliance: Furnish certification that standards specified herein are met.

PART 2 - PRODUCTS

2.01 GEOTEXTILE

- A. Type A Geotextile: Type A Geotextile shall be a nonwoven geotextile with a minimum puncture resistance of 110 pounds (ASTM D-4833). Geotextile shall be PROPEX Geotex 801 or an Engineer approved equivalent.
- B. Type B Geotextile: Type B Geotextile shall be a non-woven coir fabric made from 100 percent biodegradable coconut fiber strands (coir) formed into a uniform blanket. The blanket is made of mattress coir evenly distributed over the entire area of the blanket. Netting is not required, however 100 percent biodegradable netting may encase the coir strands. Use a blanket of no less than 5 mm in thickness and a minimum weight of 325 grams per square meter of fabric. Geotextile shall be a BonTerra C2 or an Engineer approved equivalent.

- C. Silt fence shall have minimum permittivity of 10 gal/min/ft² (ASTM D-4491). The silt fence shall be PROPEX Geotex style 2130 or Engineer approved equivalent.

2.02 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Each roll of geosynthetic material shall be packaged individually in a suitable sheet, wrapper or container to protect the fabric during normal storage and handling, from damage due to ultraviolet light, and moisture.
- B. Labeling: Each roll shall be identified by a tag or label securely affixed to the outside of the roll on one end. The label shall include the manufacturer or supplier, the style number and the roll number.
- C. Storage: Store all geosynthetic materials elevated off the ground and ensure that they are adequately covered.
- D. Geosynthetics damaged during transport, storage or placement shall be replaced at no expense to FWP.

PART 3 - EXECUTION

3.01 SITE PREPARATION

The area to be covered by the geotextile shall be graded to a smooth condition free from protruding objects such as rocks, sticks and other debris. Maximum care must be taken to remove all objects that would damage the geosynthetic.

3.02 INSTALLATION

- A. Type A Geotextile
 1. The geotextile shall be spread immediately ahead of the covering operation. The geotextile shall be laid smooth and pulled taut without excessive wrinkles. The geotextile shall not be dragged through mud or over sharp objects, which could damage the geotextile.
 2. Overlap adjacent panels a minimum of 2 feet or as specified by the manufacturer.
 3. Pegs, pins, or the manufacturer's recommended method shall be used as needed to hold the geotextile in place until the specified cover material is placed.
 4. Install filter fabric between riprap and subgrade in accordance with the Drawings.

B. Type B Geotextile

1. The geotextile shall be spread immediately ahead of the covering operation. The geotextile shall be laid smooth and pulled taut without excessive wrinkles. The geotextile shall not be dragged through mud or over sharp objects, which could damage the geotextile.
2. Overlap adjacent panels a minimum of 2 feet or as specified by the manufacturer.
3. Provide either “T” shaped hardwood stakes or biodegradable pins for anchoring seams and edges of the coir matting with the following approximate dimensions: leg length: 280 mm, head width: 32 mm, head thickness: 11 mm, leg width: 15 mm (tapered to a point), leg thickness on fabric seams and edges: 11 mm, total length: 305 mm. Provide wood stakes that are solid, that will not split or crack, and are free of rot. Contractor may fabricate stakes or may purchase stakes. Provide 203 mm steel staples for use in stapling interior spaces of fabric segments. One manufacturer of staples and stakes meeting these specifications is North American Green (available from Roscoe Steel).
4. Install the erosion control fabric to the grade and elevation shown on the Plans. Staple (stake) the fabric in place using manufacturer’s recommendations for stream bank application or alternative method as approved by Engineer. Space stakes on fabric seams and edges a maximum of 1 foot center to center. Install stakes flush with the fabric surface. Install 8 inch steel staples throughout interior spaces of fabric segments. Space staples throughout fabric segments a maximum of 2 feet center to center. Install fabric so that the upstream segment is overlapping the neighboring downstream segment. Place topsoil and seed below the fabric as shown on plans. Smooth the topsoil to allow the fabric to lay flat. Ensure the fabric has full contact with the soil beneath and no voids exist.

C. Silt Fence

1. Contractor may install silt fence as part of Best Management Practices to be used for erosion/sediment control adjacent to Greenhorn Creek.
2. Silt Fence shall be installed on the stream side of all improvements as directed by ENGINEER but shall not be installed in direct contact with the stream.
3. Adjacent panels of silt fencing shall be joined in accordance with the recommendations of the manufacturer.

4. At ENGINEER option, samples of the silt fence geotextile shall be submitted for material property confirmation testing.
5. All silt fence geotextile which has defects, deterioration, or damage as determined by ENGINEER may be rejected by ENGINEER and replaced at Contractor's expense.
6. Sediment deposits in excess of $\frac{1}{2}$ the height of the silt fence shall be removed and transported to an ENGINEER designated area.

3.03 REPAIRS AND SPECIAL INSTALLATION

- A. Should the geotextile be torn or punctured, the damaged area shall be repaired or replaced to manufacturer's specifications by the contractor at no cost to FWP. The repair shall consist of a patch of the same type material.
- B. Geotextile patching shall overlap the existing geotextile a minimum of 3 feet from the edge of any part of the damaged area.
- C. For silt fence, a new section of silt fence shall be installed of sufficient length to span, at a minimum, two posts. New section of material shall be joined to existing by sewing.

3.04 CONTROL SAMPLING

For geotextiles, GCL, and silt fence, ENGINEER representative may randomly select and obtain samples from rolls and samples of seams after arrival at the site and prior to installation. The minimum sample size from a roll shall be 1.5 yards by the full roll width.

END OF SECTION 02710

SECTION 02910
SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section includes ground surface preparation, furnishing all seeding, mulch, labor, equipment, and materials to revegetate the areas impacted during construction activities, temporary diversion channels, permanent stream channel alterations, dikes, waste material areas and/or other areas shown on the Drawings and described in the contract documents.

- B. Unapproved areas of disturbance which are disturbed by the Contractor's operation will also require seeding and mulching. Any such disturbed areas will be considered as site damage and will not be measured or considered for payment.

1.02 RELATED SECTIONS

Section 02110 – Site Clearing
Section 02200 – Unclassified Excavation
Section 02210 – Fill Materials and Placement Requirements
Section 02270 – Stream Channels and Diversions

1.03 SUBMITTALS

- A. Submit the following to ENGINEER: Certificates of Compliance: Furnish certification that standards specified herein are met.

PART 2 PRODUCTS

2.01 SEED MIXTURES

- A. Type A seed mix shall conform to the following specifications:

	<u>Grass Species</u>	<u>% PLS Count</u>
●	Western Wheatgrass* <i>*(substitute Thickspike for sandy soils)</i>	30%
●	Streambank Wheatgrass	20%
●	Hard Fescue* <i>*(substitute Green Needlegrass for silty and clay soils)</i>	20%
●	Slender Wheatgrass	15%
●	<i>Green Needlegrass (wildlife)</i>	15% to 10%
●	-others-	+/-10%

- B. Do not use wet, moldy or otherwise damaged seed in the work.
- C. Seed mixture shall be applied at the following PLS rates:
 - Drilled Rate = 8 lbs./acre
 - Broadcast Rate = 16 lbs/acre
 - Hydroseed Rate = 16 lbs/acre
- D. COVER SOIL
 - 1. Use salvaged cover soil as specified in Section 02210. Cover soil shall be loose, friable, soil, free of excess acid and alkali. Assure cover soil does not contain objectionable amounts of sod, hard lumps, large rocks, or other undesirable material that would form a poor seedbed.

2.02 MULCHING MATERIAL

- A. Mulch shall be vegetative mulch.
- B. All mulch shall be “Montana certified weed-seed free mulch”.
- C. Grass hay or straw mulch is subject to the ENGINEER approval.

PART 3 EXECUTION

3.01 COVER SOIL

- A. Place at least 6 – loose inches of cover soil in all areas to be seeded.

3.02 ALLOWABLE SEEDING MONTHS

- A. Perform seeding when the temperature and moisture are favorable to germination and plant growth. Seed preferably before June 1 and after October 1 of each year. Seeding dates must be approved by Owner.

3.03 SEEDBED PREPARATION, SOWING AND MULCHING

- A. Clear the areas to be seeded of all debris, vegetation, and other material as determined by the Engineer to be detrimental to the preparation of the seedbed. The ground surface shall be brought to the lines and grades shown on the Drawings to blend with the adjacent topography at the completion of grading. The cover soil shall be brought to a friable condition as directed by the Engineer. A disk, harrow or other implement approved by the Engineer shall be used. Assure the prepared seedbed surface is firm enough to prevent

seed loss from high winds or normal rainfall. If rolling is required, perform rolling before seeding using a suitable roller, of a weight appropriate to the soil conditions.

- B. Sow seed in the areas described in these specifications and contract documents at the specified application rates.
- C. Vegetative mulch shall be applied at a rate of 3,000 pounds per acre. Grass hay or straw mulch shall be anchored by a mulch tilled crimper or other device approved by the Engineer.

END OF SECTION 02910

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

This Section specifies cast-in place concrete, including formwork, reinforcing, resin anchored rock bolts, mix design, placement procedures and finishes.

1.02 RELATED SECTIONS

Section 02210 – Fill Materials and Placement Requirements
Section 02220 – Excavating

1.03 SUBMITTALS

Submit the following to ENGINEER:

- A. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, curing compounds, and others as requested by ENGINEER.
- B. Shop Drawings for reinforcement for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Laboratory test reports for concrete materials and mix design test.
- D. Materials certificates in lieu of materials laboratory test reports when permitted by ENGINEER. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- E. Product Data: Manufacturer's specifications and instructions for color additives and curing compounds.

1.04 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and elevations of embedded utilities and components which are concealed from view.

1.05 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 318: Building Code Requirements for Reinforced Concrete.
2. Concrete Reinforcing Steel Institute (CRSI): Manual of Standard Practice.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II: Use one brand of cement throughout project unless otherwise acceptable to ENGINEER. See General Notes Sheet 6.
- B. Fly Ash: ASTM C 618, Type C or Type F.
- C. Normal Weight Aggregates: ASTM C 33. Provide aggregates from a single source for exposed concrete.

For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.

Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to ENGINEER.

- D. Water: Potable.
- E. Admixtures.
1. Provide admixtures that contain not more than 0.1 percent chloride ions.
 2. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures. Use air-entraining admixture in all concrete. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 5 percent with a tolerance of plus or minus 1 percent.
 3. Water-Reducing and Set-Control Admixtures: Subject to acceptance by ENGINEER, provide water-reducing or set-control admixtures complying with ASTM C 494. Use admixtures for water reduction

and set control in strict compliance with manufacturer's directions.
Designate admixture types as follows:

Type A	Water-reducing admixtures.
Type B	Retarding admixtures.
Type C	Accelerating admixtures.
Type D	Water-reducing and retarding admixtures.
Type E	Water-reducing and accelerating admixtures.

Use only admixtures which have been incorporated and tested in accepted design mixes and which have been proven compatible with other components of the mix. Use in compliance with manufacturer's printed directions and recommendations.

- F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement of not more than 4 inches.

2.02 SYNTHETIC FIBER REINFORCEMENT

- A. Synthetic Fiber Reinforcement: Fibermesh 300.
1. Material: 100 percent virgin homopolymer polypropylene fibrillated fibers, containing no reprocessed olefin materials.
 2. Conformance: ASTM C 1116, Type III.
 3. Fire Classifications:
 - a. UL Report File No. R8534-11.
 - b. Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1.
 4. Fiber Length: Graded
 5. Alkali Resistance: Alkali proof.
 6. Absorption: Nil.
 7. Specific Gravity: 0.91.
 8. Melt Point: 324 degrees F (162 degrees C)

2.03 HARDENING, SEALING AND FINISH MATERIALS

- A. General: Apply all hardening, sealing and finishing treatments in accordance with manufacturer's recommendations. Refer to the schedule below for applications.
- B. Cure, Seal, Dustproofing: Use Kure-N-Seal by Sonneborne or ENGINEER-approved equal.
- C. Hardener: Use Lapidolith by Sonneborne or ENGINEER-approved equal.

2.04 RELATED MATERIALS

- A. Absorptive Cover: Use burlap cloth made from jute or kenaf, dry weight

approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

- B. Moisture-Retaining Cover: Use one of the following, in compliance with ASTM C 171:

Waterproof paper.
Polyethylene film.
Polyethylene-coated burlap.

- C. Liquid Membrane-Forming Curing Compound: Use liquid membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss shall not be more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.

- D. Evaporation Control: Use monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Eucobar," Euclid Chemical Co.
"E-Con," L&M Construction Chemicals, Inc.
"Confilm," Master Builders, Inc.

- E. Bonding Compound: Acrylic or styrene butadiene.

Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Acrylic Bondcrete," The Burke Co.
"Day-Chem Ad Bond," Dayton Superior Corp.
"SBR Latex," Euclid Chemical Co.
"Daraweld C," W.R. Grace & Co.
"Hornweld," A.C. Horn, Inc.
"Everbond," L & M Construction Chemicals, Inc.
"Acryl-Set," Master Builders Inc.
"Intralok," W.R. Meadows, Inc.
"Sonocrete," Sonneborn-Rexnord.

- F. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.

Available Products: Subject to compliance with requirements, products that

may be incorporated in the work include, but are not limited to, the following:

- "Burke Epoxy M.V.," The Burke Co.
- "Euco Epoxy System #452 or #620," Euclid Chemical Co.
- "Epoxtite Binder 2390," A.C. Horn, Inc.
- "Epabond," L&M Construction Chemicals, Inc.
- "Concresive 1001," Master Builders, Inc.
- "Sikadur 32 Hi-Mod," Sika Corp.

- G. Resin for Rock Anchors: Filled polyester mastic resin cartridges are recommended. The resin shall be supplied in cartridge form, 16 in long, and as large in diameter as the hole will allow. The cartridge shall contain two distinct fractions of filled polyester mastic and catalyst paste without an intervening mechanical membrane to ensure proper mixing. The compressive strength of the mix and cured resin shall be 5,000 psi when tested in accordance with ASTM C39-71, "Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens". The gel and cure time at 75 deg. F should be between 1 minute gel time with a 10 minute cure time for the fast-set (anchoring) cartridges to a 60 minute gel time with a 4 hour cure for the slow-set (grouting) cartridges. This time may vary depending on the field conditions but should not vary more than 20 % from the specified time. Gel and cure times or cartridges shall be as specified by the manufacturer and approved by the Engineer. The material should be thixotropic and of such viscosity that the anchor bar can adequately mix the material. All cartridges shall be inspected prior to insertions to see that the polyester resin compounds have not hardened and meet the above requirements. Cartridges shall be stored so as to ensure maximum protection until their use. The Contractor shall provide facilities to prevent prolonged exposure to elevated temperatures (above (75° F) during storage. Resin shall be Minova Lokset 2816 or Engineer approved equivalent.

2.05 FORM MATERIALS

- A. Forms for Exposed Finish Concrete:
1. Use plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.
 2. Plywood shall comply with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other

acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

- C. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties:
 - 1. Use factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal.
 - 2. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.

2.06 REINFORCING MATERIALS

If the construction requires cold joints in the vertical portion of the structure (not between the apron and the vertical wall) at the cold joint, the reinforcement shall be galvanized or epoxy coated.

- A. Reinforcing Bars: ASTM A 615, Grade 60 for No. 5 and greater rebar and Grade 40 for No. 4 rebar and less, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.
- D. Rock Anchor:
 - 1. Rock Anchor shall be DYWIDAG No. 6 Threadbars, GR 75 ksi conforming to ASTM A615 or Engineer approved equivalent. The deformed bar shall have a continuous rolled-in pattern of threadlike deformations along their entire length.

2.07 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to ENGINEER for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing. See

General Notes Sheet 6.

- B. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- C. Submit written reports to ENGINEER of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until proposed mix designs have been approved by ENGINEER.
- D. Design mixes to provide normal weight concrete with the following properties:

Type A: 4000-psi 28-day compressive strength; 611 pounds cement per cubic yard minimum with a maximum water/cement ratio of 0.45.

- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by ENGINEER. Laboratory test data for revised mix design and strength results must be submitted to and accepted by ENGINEER before using in work.

2.08 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ASTM C 94.

When air temperature is between 85° F (30° C) and 90° F (32° C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90° F (32° C), reduce mixing and delivery time to 60 minutes.
- B. Add synthetic fiber reinforcement to concrete mixture in accordance with manufacturer's instructions.
- C. Add synthetic fiber reinforcement into concrete mixer before, during, or after batching other concrete materials.
- D. Application Rate: Add synthetic fiber reinforcement at minimum application rate of 1.5 pounds per cubic yard (0.9 kg/m³) of concrete.
- E. Mix synthetic fiber reinforcement in concrete mixer in accordance with mixing time and speed of ASTM C 94 to ensure uniform distribution and random orientation of fibers throughout concrete.

PART 3 EXECUTION

3.01 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, keyways, recesses, chamfers, blocking, screens, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- D. Where interior area of formwork is inaccessible for cleanout, provide temporary openings for inspection before concrete placement. Locate temporary openings in forms at inconspicuous locations. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar.
- E. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.02 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as herein specified.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by ENGINEER.

- D. Place reinforcement to obtain the specified coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Rock Anchors:
1. Rock anchors shall be installed as quickly as practical after the rock is exposed after excavation. Anchors shall be installed under the direct supervision of an ENGINEERS inspector.
 2. Holes shall be drilled to the basic rock anchor pattern shown on the drawings or as dictated by actual rock conditions. The diameter of the hole shall be in accordance with the manufacturer's recommendations taking into account the rock anchor size and the resin cartridge size.
 3. The hole diameter for each anchor shall be uniform for the entire length of the hole, when installing uncoupled rock anchor assemblies. After the bore-hole is cleaned, the resin cartridges shall be carefully inserted in the hole avoiding rupture of the cartridges before the anchor is installed.
 4. It is the intent of this specification that all polyester resin anchored rock anchors be full encapsulated with the polyester material. However, if full encapsulation with polyester is not achieved, the Contractor shall use whatever means are necessary to fully encapsulate the remainder of the anchor with either polyester resin or cement grout to the satisfaction of the Engineers and within Seven (7) days of installation of the bolt.
 5. The rock anchor shall then be inserted in the bolt-hole until it contacts the first cartridge. At this point, the anchor shall be rotated between 120 and 500 rpm and inserted at a penetration rate of approximately 2 inches – 4 inches per second. When the anchor reaches the back of the hole, rotation should continue for a minimum 100 rpm for a minimum of 35 revolutions. Anchor shall not be re-spun and initial installation procedure to avoid damaging partially set resin. The installation procedure shall avoid any damage to the thread on the projection end of the rock bolt. Anchors and resin shall be installed at temperatures between 50° F and 70° F to obtain consistent set time. The Contractor shall promptly clean up, to the satisfaction of the Engineer or FWP representative, any excess resin which flows from the hole.

3.03 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to ENGINEER.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and elsewhere as indicated on Drawings.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated.

3.04 PREPARATION OF FORM SURFACES

- A. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.
- B. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces or reinforcing steel against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete installation of formwork, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.
- B. Comply with ACI 304, "Recommended Practice for Assuring, Mixing, Transporting, and Placing Concrete."
- C. Placing Concrete in Forms: Deposit concrete continuously or in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. If a section cannot be placed continuously, provide construction joints as specified herein. Deposit concrete to avoid segregation at its final location.
- D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
- E. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower

layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

- F. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows:
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 2. Do not use frozen materials or materials containing ice or snow.
 3. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 4. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- G. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and the following:
1. Cool reinforcing steel so steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 2. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
 3. Upon prior approval by ENGINEER, use water-reducing retarding admixture as needed due to high temperatures, low humidity, or other adverse placing conditions.

3.06 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. The concrete surface will have texture imparted by form-facing material used, with tie holes and defective areas repaired and patched. Fins and other projections exceeding 1/4 inch in height shall be rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed to view. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

- C. Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.07 CONCRETE CURING AND PROTECTION

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screening and bull floating, but before power floating and troweling.
- B. After placing and finishing, start initial curing as soon as free water has disappeared from concrete surface. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Perform curing of concrete by moist curing, moisture-retaining cover curing, or combinations thereof as specified below.
 - 1. Moist Curing: Use a continuous water-fog spray to keep the concrete surface continuously wet.
 - 2. Moisture-Retaining Cover: Cover concrete surfaces with specified moisture-retaining cover placed in the widest practicable width, with sides and ends lapped at least 4 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Thoroughly saturate cover with water, and keep continuously wet for the duration of the specified curing period.
- D. Structure wall shall cure for a minimum of 3 days prior to backfilling. Backfilling of structure wall shall be conducted in two stages.
 - 1. Backfilling of structure wall in preparation of apron subgrade shall be conducted to avoid unbalanced stresses against the structure wall. Contractor shall backfill both sides (upstream and downstream) up to the apron subgrade elevation concurrently in order to minimize the potential for unbalanced stresses.
 - 2. Backfilling of the upstream side of structure shall be conducted after the apron slab has met the minimum cure period.
- E. Apron shall cure for a minimum of 2 days prior to receiving stream flows.

3.08 REMOVAL OF FORMS

Formwork not supporting weight of concrete, such as sides of walls and similar parts of the work, may be removed after curing at not less than 50° F (10° C) for 24 hours, provided concrete is sufficiently hard to not be damaged by form removal operations. Curing and protection operations as specified herein shall be maintained during and after form removal.

3.09 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and latence, and tighten forms to close joints. Align and secure joint to avoid offsets. The use of "patched" forms for exposed concrete surfaces must be approved by ENGINEER.

3.10 CONCRETE SURFACE REPAIRS

- A. Perform structural repairs with prior approval of ENGINEER for method and procedure, using specified epoxy adhesive and mortar.
- B. Immediately after removal of forms, repair and patch defective areas, as determined by ENGINEER, with cement mortar. Cut out cracks, spalls, popouts, air bubbles, fins, honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, and other defective areas, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried, or as specified in the manufacturer's printed instructions for the bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete. Repair and finish concrete surfaces as follows:
 - 1. Repair of Unformed Surfaces: Test unformed surfaces for smoothness and verify compliance with surface tolerances specified herein. Repair unformed surfaces that contain defects affecting durability, including crazing and cracks in excess of 0.01 inch wide or any cracks that penetrate to reinforcement or completely through nonreinforced sections regardless of width. Perform specific types of repairs as follows:

- a) Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 - b) Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to ENGINEER.
 - c) Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
2. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- C. Repair methods not specified above may be used, subject to acceptance of ENGINEER.

3.11 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: Contractor shall conduct sampling and testing for quality control during placement of concrete. Testing shall be conducted by an ACI certified concrete technician. Results of the testing shall be submitted to the Engineer. Testing shall include the following:
1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 2. Slump: ASTM C 143. Conduct test every day of placement for every 25 cy and more frequently if batching appears inconsistent. Conduct with strength tests.
 3. Air Content: ASTM C 231 pressure method. Conduct with slump test.
 4. Concrete Temperature. Conduct with slump tests.

5. Compression Test Specimen: ASTM C 31. One set of 4 cylinders per day and every 100 cy for each class of structural concrete.
6. Compressive Strength Tests: ASTM C 31. Test one cylinder at 3 days and two at 28 days. One field cure cylinder test shall be made when insitu strengths are required to be known. One cylinder shall be used as a duplicate.
7. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
8. Additional Tests: When test results indicate specified concrete strengths and other characteristics do not conform with those specified herein, ENGINEER may require additional tests of in-place concrete. The Contractor shall pay for such additional tests. Additional tests may include tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42.

END OF SECTION 03300